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Hydrogen Adsorption on Activated Carbon and Carbon Nanotubes Using Volumetric Differential Pressure Technique

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Abstract

In this work, we report a simple hydrogen adsorption measurement system utilizing the volumetric differential pressure technique has been designed, fabricated and calibrated. Hydrogen adsorption measurements have been carried out at temperatures 298 K and 77 K on activated carbon and carbon nanotubes with different surface areas. The adsorption data obtained will be helpful in understanding the adsorption property of the studied carbon materials using the fundamentals of adsorption theory. The principle of the system follows the Sievert-type method. The system measures a change in pressure between the reference cell, R1 and the sample cells, S1, S2, S3 over a certain temperature range. R1, S1, S2, and S3 having known fixed volumes. The sample temperatures will be monitored by thermocouple TC while the pressures in R1 and S1, S2, S3 will be measured using a digital pressure transducer. The maximum operating pressure of the pressure transducer is 20 bar and calibrated with an accuracy of ± 0.01 bar. High purity hydrogen is being used in the system and the amount of samples for the study is between 1.0–2.0 grams. The system was calibrated using helium gas without any samples in S1, S2 and S3. This will provide a correction factor during the adsorption process providing an adsorption-free reference point when using hydrogen gas resulting in a more accurate reading of the adsorption process by eliminating the errors caused by temperature expansion effects and other non-adsorption related phenomena. The ideal gas equation of state is applied to calculate the hydrogen adsorption capacity based on the differential pressure measurements. Activated carbon with a surface area of 644.87 m^2/g showed a larger amount of adsorption as compared to multiwalled nanotubes (commercial) with a surface area of 119.68 m^2/g. This study also indicated that there is a direct correlation between the amounts of hydrogen adsorbed and surface area of the carbon materials under the conditions studied and that the adsorption is significant at 77 K.